SUPINE MID-ABDOMINAL TRACTION (S.M.A.T.): LUMBAR TRACTION FOR THE REDUCTION OF SAGITTAL LUMBAR ANTERIOR TRANSLATION AND INTERSEGMENTAL TRANSLATIONS ASSOCIATED WITH LUMBAR AXIAL AND RADICULAR LEG PAIN

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ABSTRACT

Objective: To describe as a case report a novel method of compression traction to the lumbar spine and its suggested ability to reduce axial pain and bilateral radicular leg pain as a result of its application.

Clinical Features: SMAT (Supine Mid Abdominal Traction) is an intervention which allows a static load to be applied to the anterior abdomen while in a supine position with the knees flexed. Its main clinical feature appears to be its influence during SMAT on increasing intervertebral disc space.

Intervention and Outcome: A series of increasing static loads (~50N, 100N, 150N) were applied to the participant while performing SMAT. Digital radiographs, CT and CTA scans with 3D reconstructions was analyzed using PostureRay digitization, hand-drawn measurement and visual analysis. CT angiography was performed to test if any abdominal vascular compromise had occurred during the application of SMAT. The earliest data was collected over a period of 3 years, which lead to the tested method. When Supine Mid Abdominal Traction was performed, the lumbar lordosis reduced by up to 32.5% (~150N, knees flexed) compared to no SMAT (knees flexed only). A series of comparative standing sagittal lumbar radiographs were taken over a 3-year period, with SMAT being the only therapeutic intervention. This resulted in a reduction of L2-L3 intersegmental translation from an abnormal value of -6.3mm to 3.4mm, a 46.03% change. To test the safety of SMAT, CT angiography was performed with a SMAT load of ~100N with no change was evident to the caliber of the abdominal aorta during abdominal compression.

Conclusion: This case report suggests that SMAT was safe to perform, observed during its application a reduction to relative and absolute lumbar vertebral rotation angles and an increase of lumbar disc height at multiple levels. There was immediate and long term relief of lumbar axial and radicular leg pain associated with the application of SMAT. (*Chiropr J Australia 2017;45:236-248*)

Key Indexing Terms: Traction; Low Back Pain; Radicular Leg Pain; 3-D CT Reconstruction

INTRODUCTION

In this paper, I describe rehabilitation of the lumbar spine employing the use of traction for the treatment of axial lumbar pain and radicular leg symptoms. Supine Mid-Abdominal Traction, or SMAT, is a patient-centered intervention that is easy to perform. The patient in this report lay supine with the legs bent on a firm surface while a load was applied to the abdomen designed to increase the force concentration applied to the anterior abdominal wall.

This procedure was reported to provide an analgesic affect to both the lumbar spine and leg in a timely manner. Diagnostic imaging was performed in a variety of ways to assist in visualizing what influence SMAT may have had on the skeletal and vascular structures of the lumbar spine, pelvis, lower ribs and the abdominal aorta.

CASE REPORT

This case report incorporated different types of imaging in order to capture quantifiable evidence that may explain some of the biomechanical principles of SMAT and also give some clinical justification as to why the subject experienced pain relief.

For this study, digital radiographic procedures were performed at SOS International Hospital Bali, Indonesia. CT and computed tomography angiography (CTA) was performed at Chatswood Diagnostic Centre, Sydney Australia. All radiographic, CT and CTA scans were performed by a licensed/registered radiographic technician.

All radiographs and scans were executed within 5 minutes of the patient being positioned. During the imaging procedures, the patient did not move and was assisted by a technician. Digitization of the radiographs were performed by another chiropractor and a chiropractic student from Macquarie University. I performed the geometric analysis on the 3D-reconstructed images. Collection of data using the PostureRay measurement procedure (Posture Co™, Inc.) had been previously tested as a reliable method to quantify spinal displacements. (Ref 1-3)

The materials used for the application of SMAT was a painted plank of wood, a canvas bag filled with either iron sand or white rice. During the radiographic procedures iron sand was used as the load as it improved in the visualization of what occurs during SMAT by visually contrasting with the different materials incorporated into the modality. (See images 3-6)

Considering that during a CT or CTA scan inorganic material may deflect from good quality imaging of the participant, iron sand was replaced with the organic material, white rice. (See image 7,8)

Interventions Performed

Supine radiographs were taken of the participant during varied applications of SMAT(See figures 3-5). The weight of the canvas bag attached to the plank of wood during the imaging of SMAT was 5, 10, and 15 kilograms. (See figure 3,4,5) In addition, supine lateral lumbar pelvic radiographic images with knees flexed and legs straight were performed with the knees flexed images used as a comparative control to the SMAT radiographic images (see figure 2 and table 4). All radiographs were performed supine except the comparative standing lateral lumbar pelvic radiographs. These standing images were taken in order to observe and measure the possible the long term skeletal alignment outcomes that may be achieved by performing SMAT (See figure 1 and tables 1-3). A series of SMAT digital radiographs were performed on the same day in the following order. (See Figures 3-5).

More advanced comparative imaging in the form of CT scans and CT angiography was also performed in order to observe the effect of SMAT on skeletal and vascular structures (See figures 7 and 8).

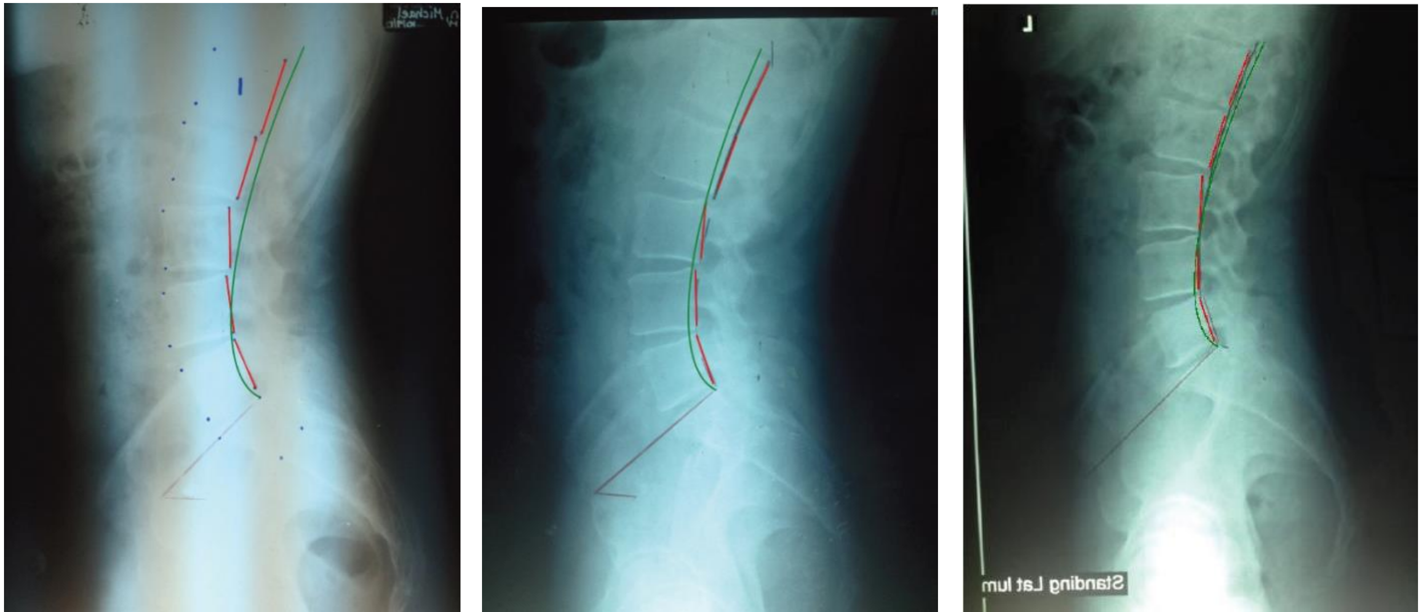
Table 1. Comparative Relative Rotation Angles
Standing Lateral Lumbar

Lumbar Spinal Level

RRA per Segment	Normal Values	09 Oct 12	29 Apr 14	13 Nov 14	% Change: Xrays 9/10/12 to 29/4/14	% change: Xrays 09/10/12 to 13/11/14
L1-L2	-5°	-1.0°	-4.9°	-3.7°	390.0%	270%
L2-L3	-6°	-17.9°	-15.1°	-13.7°	15.6%	23.46%
L3-L4	-9°	-7.0°	-5.6°	-4.1°	20.0%	41.43%
L4-L5	-19°	-15.7°	-18.2°	-18.2°	15.9%	15.9%
L5-S1	-33°	-30.4°	-30.4°	-33.6°	0.0%	10.53%
Sacral Base	40°	46.1°	39.0°	44.4°	15.4%	3.7%

RRA = Relative Rotational Angle of Measurement

Figure 1. Standing Lateral Lumbar Pelvic. Comparative views of subject



Standing Lateral Lumbar 09 Oct 2012 Standing Lateral Lumbar 29 April 2014 Standing Lateral Lumbar 13 November 2014

Table 2. Comparative Absolute Rotation Angles and Z Axis Translation

Global Analysis	Normal Value	09 October 2012	29 April 2014	13 Nov 14	% Change: Xrays 9/10/12 to 29/4/14	% change: Xrays 09/10/12 to 13/11/14
ARA L1-L5	-40°	-41.6°	-43.7°	-39.7°	5.0%	4.57%
Translation L1-S1	0 mm	8.4 mm	-4.6 mm	7.3mm	154.8%	13.1%

ARA = Absolute Rotational Angle of measurement

Table 3. Comparative Intersegmental Z Axis Translation

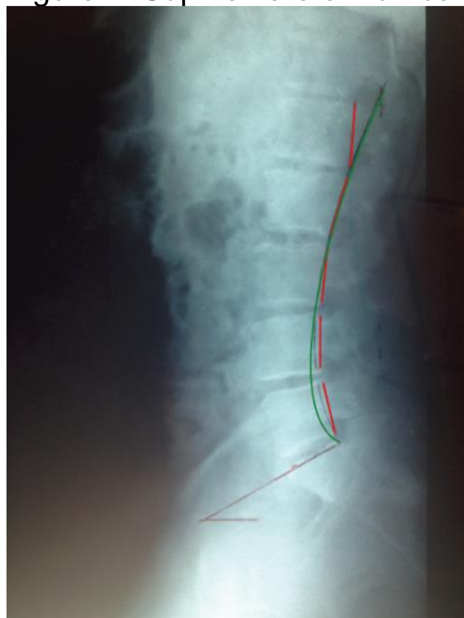
RRA per Segment	09 October 2012	29 April 2014	13 Nov 2014	% Change: Xrays 9/10/12 to 29/4/14	Comment % change: Xrays 09/10/12 to 13/11/14

Lumbar Traction
Epstein

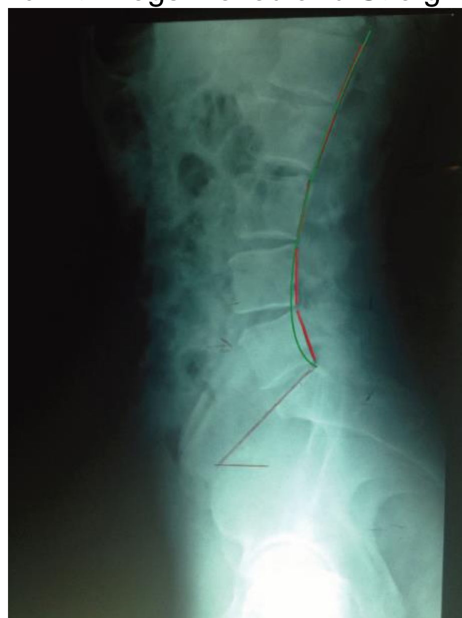
L1-L2	-4.0mm	-0.3mm	-0.7mm	92.5%	82.5%
L2-L3	**-6.3mm***	**-4.8mm***	**-**3.4mm	23.8%	46.03%
L3-L4	-4.4mm	-3.4mm	-1.5mm	22.7%	65.9%
L4-L5	-0.3mm	-1.5mm	-1.1mm	600%	266.7%
L5-S1	-2.8mm	-0.7mm	0.5mm	75%	117.9%

***Outside Normal Established Values**

Figure 2. Supine Lateral Lumbar Pelvic with Legs Flexed and Straight.



Supine Knees Flexed 29 April 2014



Supine Knees Straight 29 April 2014

Table 4. Comparative Relative Rotation Angles
Knees Flexed / Knees Straight
Lumbar Spinal Level

RRA per Segment	Normal Values	Knees Flexed	Knees Straight	% Change: Xrays Knees Flexed to Knees Straight	Comment
L1-L2	-5°	12.4°	-3.6°	129.0%	KF > Kyphosis
L2-L3	-6°	-11.1°	-7.7°	30.6%	KF > Lordosis
L3-L4	-9°	-5.7°	-12.4°	117.5%	KF < Lordosis
L4-L5	-19°	-13.2°	-19.2°	45.5%	KF < Lordosis
L5-S1	-33°	-31.3°	-40.2°	28.4%	KF < Lordosis
Sacral Base	40°	29.4°	42.9°	45.9%	KF < Sacral Base Angulation

RRA = Relative Rotational Angle of measurement
KF = Knees Flexed

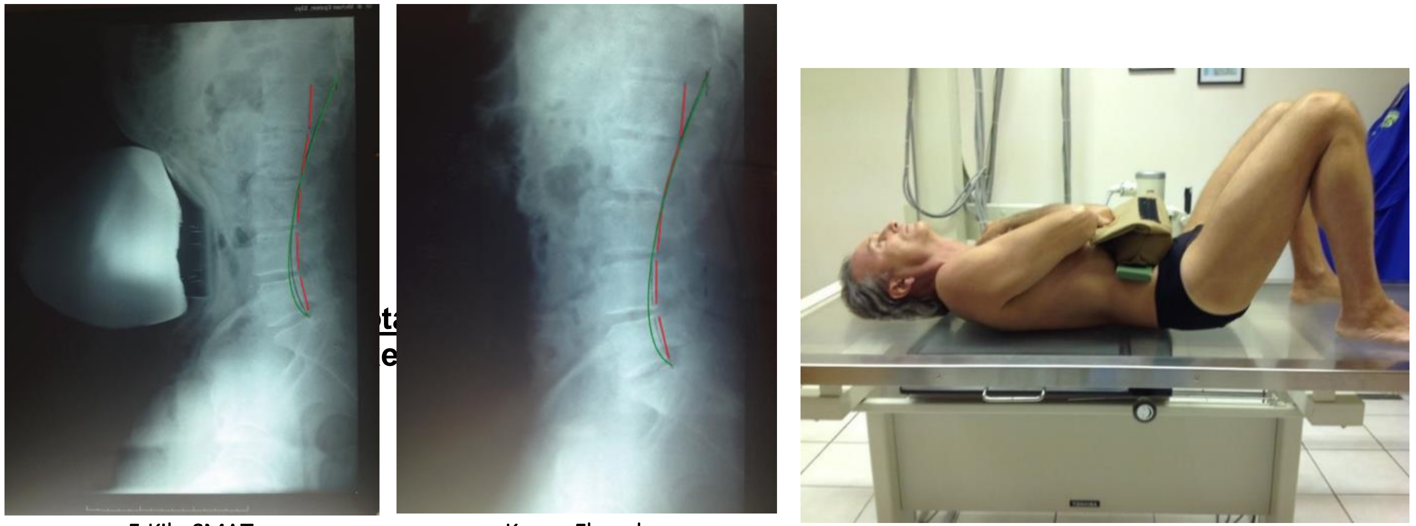
Table 5. Comparative Absolute Rotation Angles and Z Axis Translation

Global Analysis	Normal Value	Knees Flexed	Knees Straight	% Change: Xrays Knees Flexed to Knees Straight	Comment
ARA L1-L5	-40°	-17.5°	-42.9°	145.1%	KF < Lordosis

Translation L1-S1	0 mm	13.4 mm	2.7 mm	79.9%	KF > Translation

ARA = Absolute Rotational Angle of measurement
KF = Knees Flexed

Figure 3. Supine Lateral Lumbar Pelvic with knees flexed while performing Supine Mid Abdominal Traction (SMAT) using 5 kg.



5 Kilo SMAT   Knees Flexed   **Michael Epstein, D.C. performing SMAT**

Table 6. Lumbar Spinal Level

RRA per Segment	**Normal Values**	**SMAT 5kilo**	**Knees Flexed**	**% Change: Xrays 5 Kilo Knees Flexed**	**Comment**
L1-L2	-5°	6.7°	12.4°	85.1%	SMAT < Kyphosis
L2-L3	-6°	-6.3°	-11.1°	76.2%	SMAT < Lordosis
L3-L4	-9°	-5.1°	-5.7°	11.8%	SMAT < Lordosis
L4-L5	-19°	-12.3°	-13.2°	7.3%	SMAT < Lordosis
L5-S1	-33°	-31.4°	-31.3°	0.3%	SMAT > Lordosis
Sacral Base	40°	31.9°	29.4°	7.8%	SMAT > Sacral Base Angulation

RRA = Relative Rotational Angle of measurement

Translation Table 7. Comparative Absolute Rotation Angles and Z Axis

Global Analysis	**Normal Value**	**SMAT 5kilo**	**Knees Flexed**	**% Change: Xrays 5 Kilo Knees Flexed**	**Comment**
ARA L1-L5	-40°	-16.9°	-17.5°	3.6%	SMAT < Lordosis
Translation L1-S1	0 mm	15.0 mm	13.4 mm	10.7%	SMAT > Translation

ARA = Absolute Rotational Angle of measurement

Figure 4. Supine Lateral Lumbar pelvic while performing SMAT using 10 kg load.
Figure 4

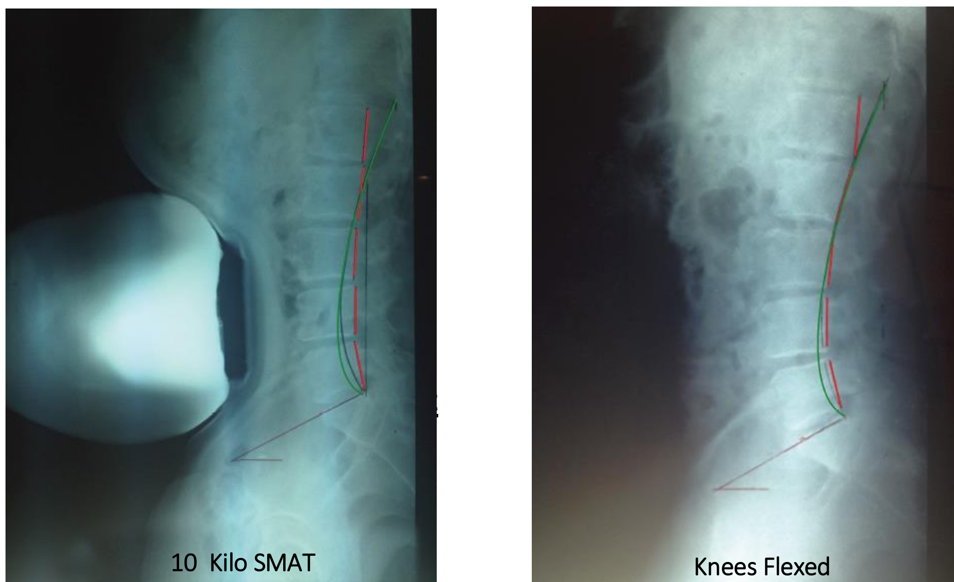


Table 8. Comparative Relative Rotation Angles
10 kilo SMAT / Knees Flexed
Lumbar Spinal Level

RRA per Segment	Normal Values	SMAT 10 kilo	Knees Flexed	% Change: Xrays 10 Kilo Knees Flexed	Comment
L1-L2	-5°	1.5°	12.4°	726.7%	SMAT < Kyphosis
L2-L3	-6°	-2.9°	-11.1°	282.8%	SMAT < Lordosis
L3-L4	-9°	-3.5°	-5.7°	62.9%	SMAT < Lordosis
L4-L5	-19°	-11.5°	-13.2°	14.8%	SMAT < Lordosis
L5-S1	-33°	-29.9°	-31.3°	4.7%	SMAT < Lordosis
Sacral Base	40°	25.8°	29.4°	14.0%	SMAT < Sacral Base Angulation

RRA = Relative Rotational Angle of measurement

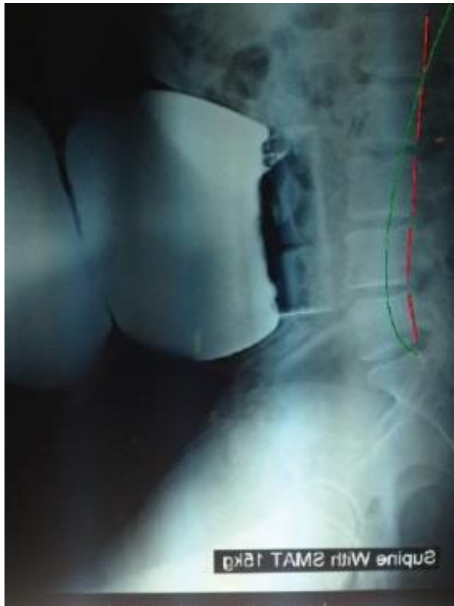
Table 9. Comparative Absolute Rotation Angles and Z Axis Translation

Global Analysis	Normal Value	SMAT 10 kilo	Knees Flexed	% Change: Xrays 10 Kilo Knees Flexed	Comment
ARA L1-L5	-40°	-16.3°	-17.5°	7.4%	SMAT < Lordosis

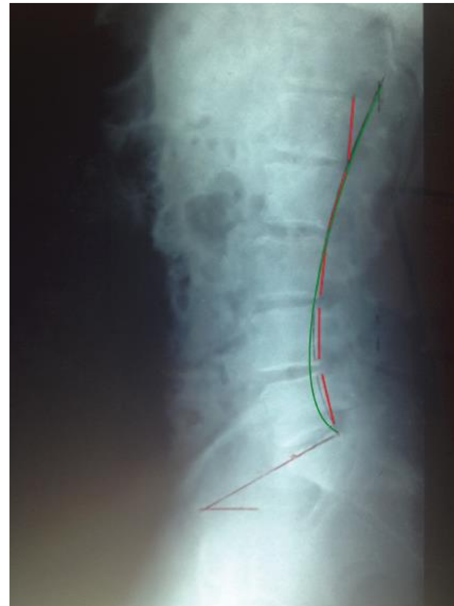
Translation L1-S1	0 mm	14.6 mm	13.4 mm	8.2%	SMAT > Translation

ARA = Absolute Rotational Angle of measurement

Figure 5. Supine lateral lumbar pelvic while performing SMAT using 15 kg load.



15 Kilo SMAT



Knees Flexed

Table 10. Comparative Relative Rotation Angles
15 kilo SMAT / Knees Flexed
Lumbar Spinal Level

RRA per Segment	**Normal Values**	**SMAT 15kilo**	**Knees Flexed**	**% Change: Xrays 15 Kilo Knees Flexed**	
L1-L2	-5°	1.1°	12.4°	1027%	SMAT < Kyphosis
L2-L3	-6°	-1.5°	-11.1°	640%	SMAT < Lordosis
L3-L4	-9°	0.1°	-5.7°	5800%	SMAT < Lordosis
L4-L5	-19°	-13.4°	-13.2°	-1.49%	SMAT < Lordosis
L5-S1	-33°	-28.0°	-31.3°	11.78%	SMAT < Lordosis
Sacral Base	40°	26.6°	29.4°	10.52%	SMAT < Sacral Base Angulation

RRA = Relative Rotational Angle of measurement

Table 11. Comparative Absolute Rotation Angles and Z Axis Translation

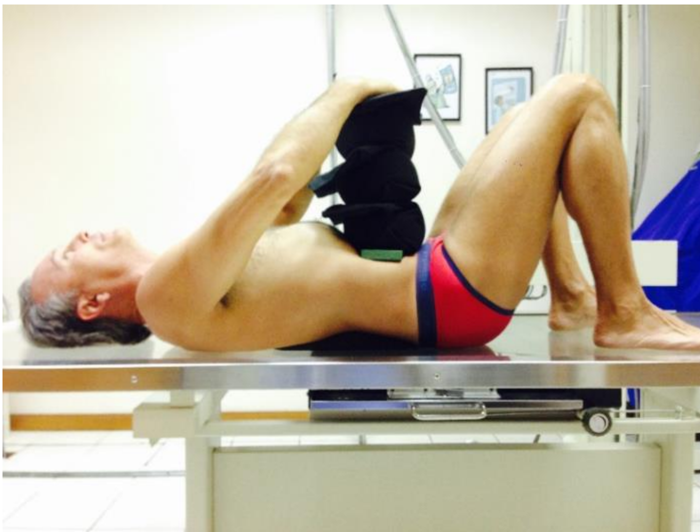
Global Analysis	**Normal Value**	**SMAT 15kilo**	**Knees Flexed**	**% Change: Xrays 15 Kilo Knees Flexed**	**Comment**
ARA L1-L5	-40°	-13.2°	-17.5°	32.57%	SMAT < Lordosis

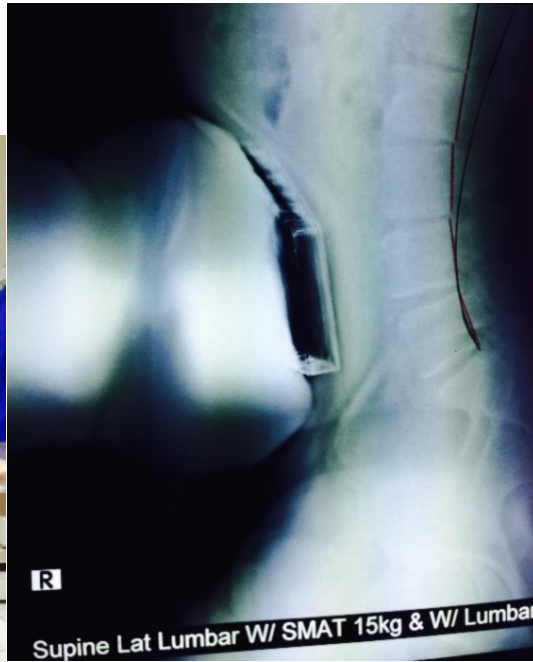
Translation L1-S1	0mm	11.5mm	13.4mm	16.52%	SMAT < Translation

ARA = Absolute Rotational Angle of measurement

Figure 6. Supine lateral lumbar pelvic while performing SMAT while lying on an elliptical shaped lumbar supportive.

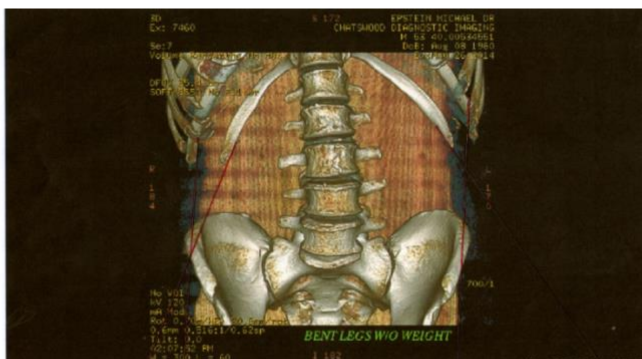
SMAT 15 kilograms with use of Lumbar Support



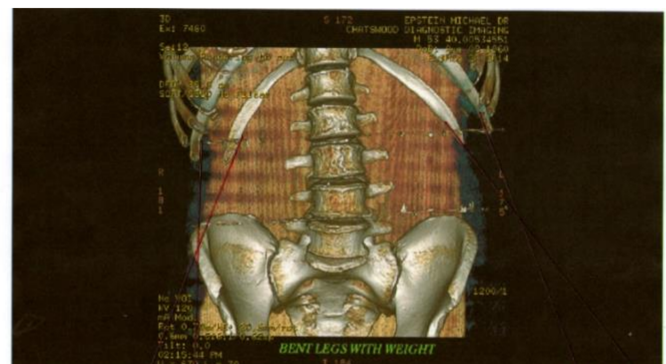


3D reconstruction using computerized tomography ***(Fig. 7)***
A novel method of quantifying comparative change in skeletal position involved the imaging of the participant using CT 3D reconstruction. This process allows the capturing of the spine and ribs and by use of SMAT a spatiotemporal reconstruction of the skeletal model was created and geometrically measured for comparison. The main objective of this procedure was to obtain an unobstructed view of the lumbar pelvic region and its positional relationship with ribs 10, 11 and 12. With no visual obstruction, a comparative measurement when SMAT with knees flexed as opposed to no SMAT with knees flexed could be evaluated for changes in position.

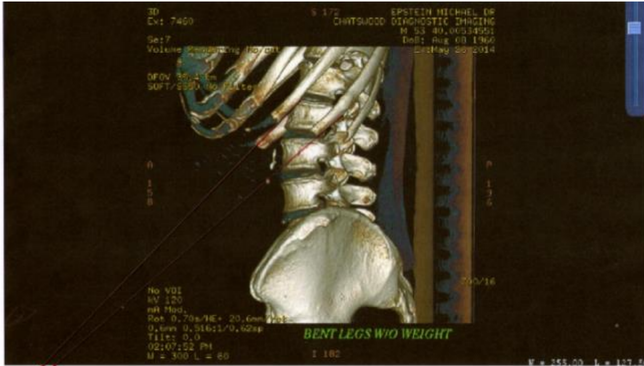
Figure 7. Comparative CT 3D Reconstruction



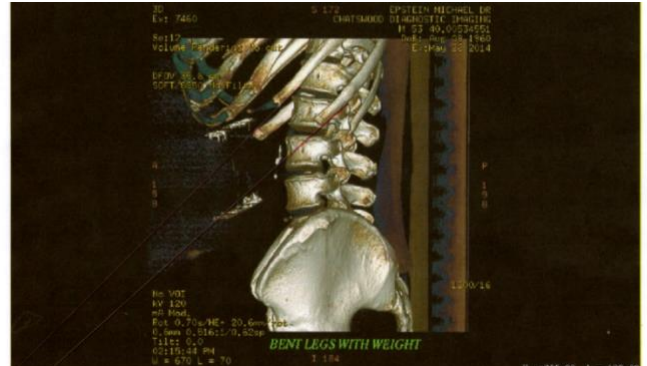
Supine AP Lumbar Pelvic and Ribs 11 and 12, without SMAT, but knees flexed
Angulation of left ribs 11 and 12 = 37°
Angulation of right ribs 11 and 12 = 18°



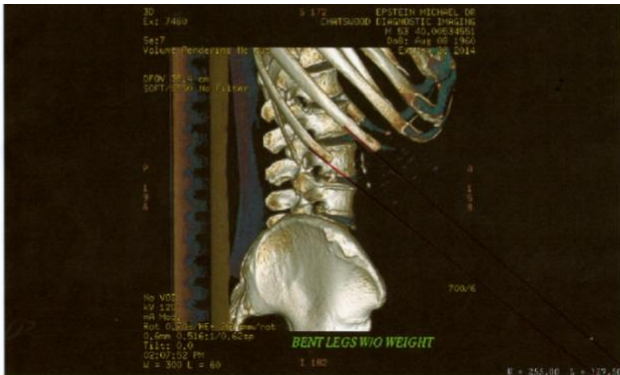
Supine AP Lumbar Pelvic and Ribs 10, 11 and 12, while performing SMAT with knees flexed
Angulation of left ribs 11 and 12 = 18°
Angulation of right ribs 11 and 12 = 20°



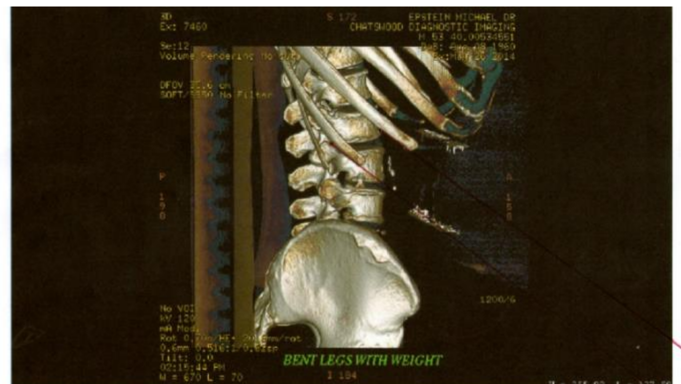
Supine Left Lateral Lumbar Pelvic and Ribs 10, 11 and 12 without SMAT but knees flexed
Angulation of left ribs 10 and 11 = 5°
Distance between Ribs 10 and 11 = 8mm



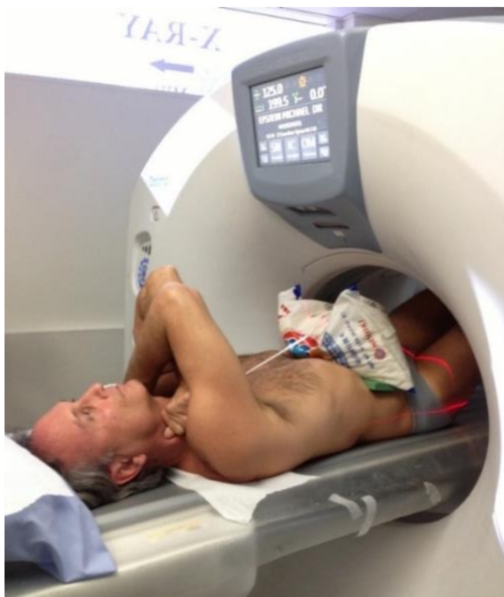
Supine Left Lateral Lumbar Pelvis and Ribs 10, 11 and 12 while performing SMAT with knees flexed
Angulation of left ribs 10 and 11 = 3°
Distance between Ribs 10 and 11 = 9mm

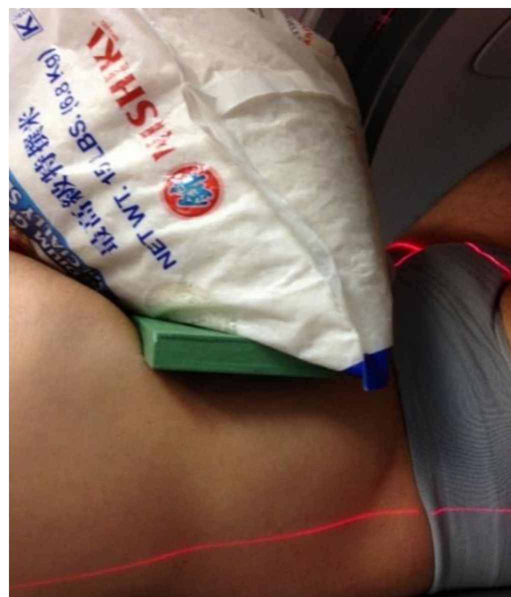


Supine Right Lateral Lumbar Pelvic and Ribs 10, 11 and 12 without SMAT with knees flexed
Angulation not measurable as distal end of ribs are almost parallel.



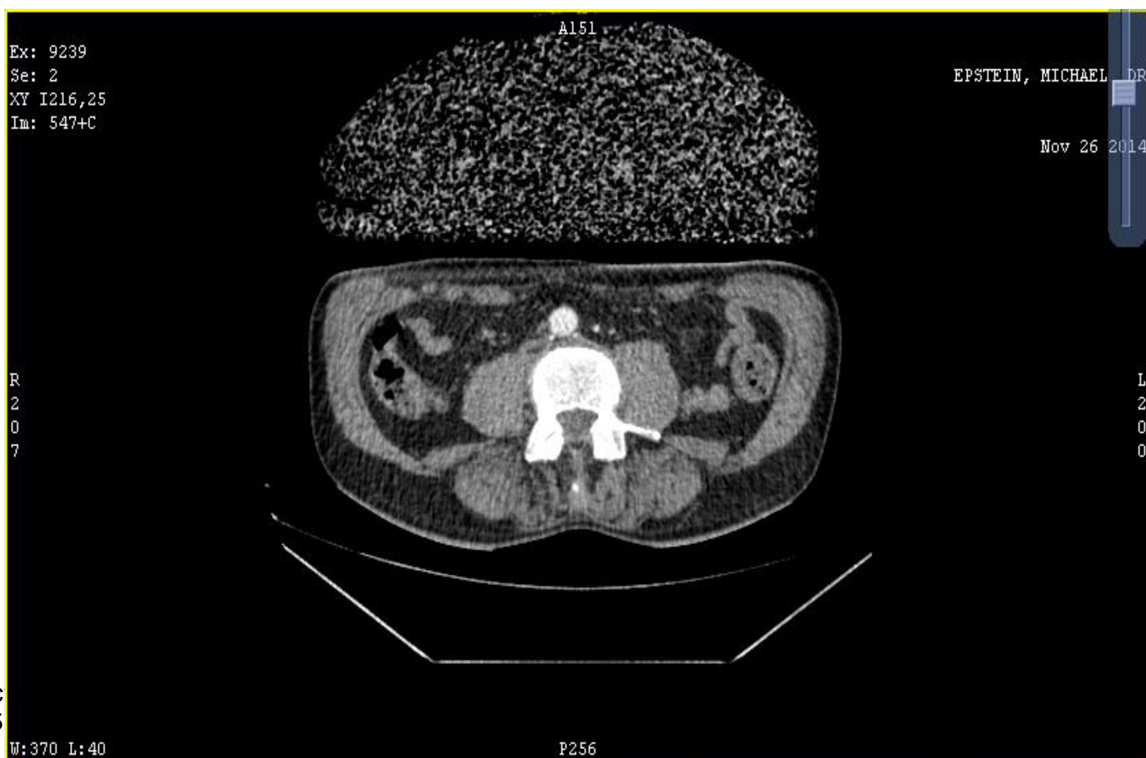
Supine Right Lateral Lumbar Pelvic and Ribs 10, 11 and 12 while performing SMAT with knees flexed
Angulation not measurable as distal end of ribs are almost parallel.
Distance between Ribs 10 and 11 = 10mm





SMAT 10 kilograms during CT Angiogram

Figure 8. Dynamic 3D reconstruction using computerized tomography angiography (CTA). In addition to skeletal quantification measurement imaging, computerized tomography angiography (CTA) was executed while performing SMAT. This dynamic low dose high resolution CT scan was useful as it provided 3D information on the shape of the abdominal aorta while under load during the application of supine mid abdominal traction.



OUTCOME OF INTERVENTION

Figure 1 and tables 1-3 present case reported results of the subject's absolute and relative rotations angles and translations digitized and measured using the PostureRay mensuration analysis system. The mensuration method used has been reported to have a high inter and intra examiner reliability. (Ref 1,2,3) Figures 2–5 and tables 4-10 present images, quantified measurements of absolute, relative rotation angles, intersegmental translations and their associated percentage of positional change while under varied loads. Figure 6 provides just a visual image showing that no obvious change to sagittal curve occurred during SMAT while using a lumbar support. Figure 7 presents comparative CT 3D reconstruction while just lying supine with kneed flexed and also while performing SMAT. Comparative rib angulation measurement was hand drawn and measured.

CT scans incorporating 3D reconstruction allowed comparative data collection due to the procedures ability to capture and create a spatiotemporal reconstruction of the thoracic lumbar pelvic region. Measurement of rib angulation 10, 11, and 12 and the distances between ribs 10 and 11 was easily performed due to its unobstructed view.

The results are summarized and presented under each reconstructed view presented in figure 7. What is evident in the images are the notable changes to comparative rib positions when SMAT was performed. In addition, due to the paint applied on the wooden plank of wood of which the weight was attached, and the woods proximity to ribs 11 & 12, and its 3D skeletal parameters of angulation and distance can be sighted and the effect of the SMAT load can be further appreciated.

Figure 8 provides CTA evidence that when ~100N load is placed on the participant's abdomen no change to the circumference of the abdominal aorta under load was reported. (Ref 5)

DISCUSSION

This case report compared the effects that SMAT had on the positioning of the thoracic, lumbar and pelvic anatomy of the participant using a variety of imaging methods. What was most novel in this report was the application of 3D reconstructive computerized tomography and angiography. This type of imaging allowed for the collection of spatio-temporal measurement changes to the participant's skeletal and vascular structures when placed under compressive load. Limitation of this procedure was its inability to measure the hemodynamic status of the abdominal aorta.

Implication on What was Reported

Having the participant undergo numerous imaging procedures provided the opportunity for quantified data collection on empirical experiences the author felt subjectively. The author is cognizant that the repeatability of this case report is limited and the implications of what was reported is important to be noted. As the safety for a patient is our priority when performing any intervention, it is important to note that when SMAT was performed, no vascular compromise was evident when a 100N load was applied to the anterior abdominal wall. The participant wanted to test the compressive load of 150N but was unable to fit the required mass within the confines of the CT scanner.

The progressive loads that were placed on the participant's abdomen were captured and measured. As the loads were increased during the application of SMAT, observed increases to numerous levels of intervertebral disc spaces was observed providing timely relief to axial lumbar and leg pain.

The author suggests that the mechanism behind SMAT's ability to increase intervertebral disc space is probably mechanical due to the fact that when the load is applied to the anterior abdominal wall it is in the same axis of translation as the participant's lumbar sagittal curve. An effective inverse or mirror image of the lumbar lordosis will incur providing subsequent mirror image changes to intervertebral discs, foramen and intervertebral bodies.

In order to test if the compressive load on the abdomen was the suggested mechanism of loading that increased the intervertebral disc spaces during SMAT. The participant performed SMAT with a 150N load while lying on an elliptical lumbar support to prevent a change to the lumbar sagittal curve and when a digital image was taken no observed change to intervertebral disc height was noted (Fig 6). This suggests that the compressive load itself does not influence disc height changes but it is its ability to change vertebral position that influences change to the intervertebral disc space and height. The data from the comparative radiographs suggests that all segmental translations were reduced. Most clinically significant was the reduction of intersegmental translation L2-L3. L2-L3 reduced from 6.3 mm to 3.4 mm, a 46.03% reduction (See figure 1 and table 3). Originally the segment was not within normal established values based on AMA Guides to the Evaluation of Permanent Impairment (Ref 4). With its reduction, the author can empirically report that the lumbar spine feels more stable, lumbar pain severity was reduced from 4 to 0, using a visual analog scale, protrusion of the participant's abdomen had been reduced and the lumbar spinal stenosis symptoms had abated. It should also be noted that there was a significant reduction in frequency, severity and intensity of upper quadrant abdominal pain and bloating symptoms the participant was experiencing.

CONCLUSION

Considering that the application of SMAT is simple to perform and inexpensive to apply, compliance with this traction therapy has good expectation for usage. Future studies on its therapeutic effectiveness on patients with axial lumbar pain and discogenic lumbar radiculopathy should be trialed on a large patient group who present with radiographic confirmation of a lumbar hyper lordosis and thoracic hyper-kyphosis. Such studies should also consider the use of comparative pre and post nerve conductivity(H-reflex) tests in order to determine changes in nerve function. (Ref 6) In addition, due to the participant's subjective improvement to his dyspepsia symptoms while performing SMAT. Future clinical trials should also be tested using SMAT on patients who present with this common reported complaint.

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